Dopant-free oxygen-rich titanium dioxide: LED light-induced photocatalysis and mechanism insight

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ABSTRACT

In this work, we successfully synthesized visible light-responsive oxygen-rich titanium dioxide (O_2–TiO_2) photocatalysts. Through hydrothermal decomposi-tion of peroxo-titania complex, the in situ generation of oxygen significantly shifted the light absorption toward visible region. The existence and contribu-tion of oxygen excess defect present in O_2–TiO_2 was confirmed through FTIR and XPS analysis. The annealing temperature influenced the oxygen content and textural property of O_2–TiO_2 samples and subsequently their photocatalytic activity. The O_2–TiO_2 calcined at optimum temperature of 300 °C recorded the highest photocatalytic activity toward methylene blue degradation, approxi-mately 7.3- and 3.2-fold higher than that of commercial P25 and anatase TiO_2, respectively. The enhancement was attributed to shortening of band gap and low recombination rate of charge carriers when the oxygen content increased at higher temperature. In addition, O_2–TiO_2 displayed high reusability rate and good catalytic stability after being evaluated by four consecutive catalytic runs. The reactive radical species responsible for charge transfer mechanism and high photocatalytic activity were hydroxyl radical ($^{\cdot}OH$), holes and superoxide rad-ical anions ($^{\cdot}O_2^-$) after performing multiple scavenging tests.